Feeding Rates and Nutrient Assimilation in the Millipede *Jonespeltis splendidus* (Diplopoda, Paradoxosomatidae)

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ABSTRACT

Laboratory studies have been conducted on the feeding and egestion of the millipede *Jonespeltis splendidus*. The millipedes were found highly specific in their diet. Ingestion and egestion rates varied with the component of the diet as well as with the sex of the individuals. Acceptability of the food depended on the moisture content and the material softness. Palatability was based on the nitrogen levels of the food. Egestion rates were directly proportional to the quantity ingested. Further, the percentage of assimilation was found to be higher with litter. The nutrient uptake by the millipede was recorded at the rate of 62, 26 and 12% with respect to proteins, fats and carbohydrates. With the feeding recorded rates the consumption by the millipede was estimated to be about 4-5 grams of dry litter per year per millipede. As the sampled population density ranged near 200 millipedes per square metre, the rate of the litter breakdown would approach 1 kg per year, per suare metre.

RÉSUMÉ

Taux d'ingestion et d'assimilation chez le diplopode *Jonespeltis splendidus* (Diplopoda, Paradoxosomatidae).

Des études en laboratoire ont été menées sur la consommation et la réjection chez le diplopode *Jonespeltis splendidus* qui montre une relation hautement spécifique vis-à-vis de son régime alimentaire. Les taux d'ingestion et d'égestion varient avec la composition de la nourriture et avec le sexe des individus. L'appétance pour la nourriture dépend du taux d'humidité et de la souplesse du matériel, de même que de son contenu en azote. Le taux de consommation correspond à la quantité de matériel ingéré ; toutefois, le pourcentage d'assimilation paraît plus élevé dans le cas de consommation de litière. On a enregistré pour le diplopode un apport nutritif de 62, 26 et 12% en rapport avec les protéines, les lipides et les glucides. En fonction des taux d'ingestion mesurés, la consommation par le diplopode est estimée à environ 4-5 grammes de litière sèche par an et par individu. La densité de la population étant estimée à environ 200 diplopodes par mètre carré, la dégradation annuelle de la litière s'établit autour de 1 kg par mètre carré.

INTRODUCTION

Jonespeltis splendidus (Verhoeff), a soil and litter dwelling millipede, is normally found in large populations under dead and decaying organic matter, under humus layers on the forest floors, in small number underneath pots in the gardens, and under stones and logs where moisture is conserved. It is also found to occur in cow dung pits. Large populations are always associated with availability of organic matter and high moisture levels. Dry litter drives the

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population away. It feeds on the substratum on which it lives and deposits pad like faecal matter on the surface that can be easily picked up as crust.

Reports are available on the food consumption and assimilation in other millipedes (see, among others, BLOWER, 1974; KAYED, 1978; BRUGGL, 1992). As *J. splendidus* is known to be a regulator and decomposer in its habitat, it was decided to record its feeding rates and nutritive requirements which were correlated to assess the fertility levels of its surroundings.

MATERIAL AND METHODS

The millipedes were collected from gardens and fields in and around Bangalore and were held in vivaria on moist garden soil (alfisol), with a layer of moist decomposing organic litter.

Before the beginning of the present experiment, the millipedes were fed on wet filter paper to clean their guts. Determination of feeding and defecation rates: one kg of finely sieved soil was spread uniformly in a glass trough 305 mm in diameter and 150 mm deep. The soils were moistened to 50% level.

100 adult millipedes, which were fed on wet filter paper earlier, were allowed to feed on the soils for four hours. After four hours of feeding the millipedes were picked and transferred to clean Petri dishes (150 mm diameter) for two hours. The covered Petri dishes were lined with wet filter papers for maintaining the humidity. The faecal pellets that were deposited in the Petri dishes were collected. The feeding and egestion rates were determined gravimetrically.

Similar experiments were conducted with Mango leaf litter. 1 kg of fine sand was uniformly laid in each glass trough and moistened to 50% level. About 200 g of wet decomposing mango leaf litter was deposited over the sand bed. The experiment then went on as mentioned earlier.

The determination of feeding rates was carried with known quantities of moistened soil and decomposing litter alone (separately) with known number of millipedes in small plastic boxes. Every day the material was weighed after picking the millipedes and separating the faeces. The difference in weight between the feed material before and after feeding was recorded as the consumption. The moisture level was maintained by covering the containers with lids lined with wet polystyrene foam.

The containers used for the experiment were maintained at 25 ± 2°C. The experiments were conducted on round the clock basis. In darkness red light was used to record observations.

Protein, carbohydrates and fats were analysed bio-chemically by adopting standard techniques.

RESULTS

The recorded food intake and defecation of adult millipedes in relation to sex (Fig. 1), when soil was used as the medium, are given in Table 1. The rate of consumption of the males was higher than that of the females. The intake of soil was higher than that of the decomposing litter in both sexes. The millipedes feed on the soft tissue of the litter, avoiding the veins and the midrib, which are woody in nature. The intake of food was dependent on the nutritive value and also on the microbial fauna of the medium, which was also reported by BLOWER (1974).

TABLE 1. — Feeding and excretory rates (mg/day) of *Jonespeltis splendidus* (Mean result for 100 individuals).

Sex	Males		Females	
Feed	Soil	Mango litter	Soil	Mango litter
Ingestion	31.84	13.2	51.54	12.2
Egestion	24.83	3.3	31.95	4.5
% Assimilation	22	75	38	63

The active period of feeding was found to be the morning hours. The feeding rates recorded during these hours are given in Table 2.

Table 3 presents the proximate composition of the mango leaf litter and the excrements of the male and female millipedes. The composition of the excrements did not differ with reference to sex. The excrements contained more nitrogen than carbohydrates. The fat contents were significantly higher in the male excrements. This suggests that the female assimilated more fats than the males, perhaps as their energy requirements are more important during ovulation.

TABLE 2. — Feeding and excretory rates of *Jonespeltis splendidus* with soils in mg. per hour (forenoon) (Mean result for 100 individuals).

Hour	1	2	3	4	5	6
Consumption	9.6	6.6	11.33	6.6	5.3	8.2
Excretion	2.3	1.0	2.5	1.0	1.9	0.9

TABLE 3. — Composition of the mango leaf litter and faecal pellets of the millipede *Jonespeltis splendidus*.

Material	mg / 100 mg dry mass (X ± S.D. ; n=4)		
	Nitrogen	Soluble Carbohydrates	Total fats
Dry mango leaf	4.34	4.50	7.54
Faeces (Female)	2.95 ± 0.47	1.83 ± 0.38	2.72
Faeces (Male)	2.41 ± 0.81	1.77 ± 0.39	3.32

Table 4 demonstrates the daily caloric intake of adults. More ingestion was noted in both sexes for proteins than for fats and carbohydrates.

TABLE 4. — Caloric intake of *Jonespeltis splendidus* (Estimated).

Food	1st day		3rd day	
	Male	Female	Male	Female
Soluble Carbohydrates	4.7871	4.7709	1.0701	1.0683
Protein	31.9737	30.9207	8.3626	7.6960
Total fats	13.3851	13.6359	3.2368	3.2733

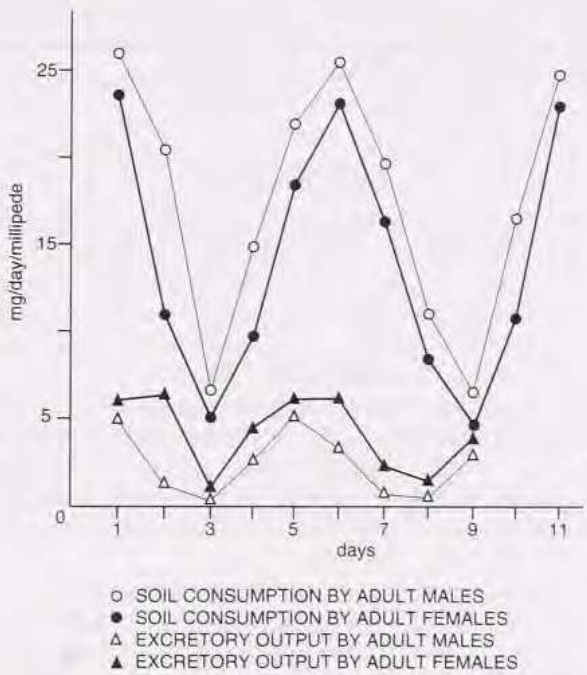

Fig. 1. — Soil ingestion and soil egestion by adult males and females of *Jonespeltis splendidus*, in relation to sex.

DISCUSSION

Earlier investigations have revealed that the millipede *Jonespeltis splendidus* is a saprophagous macroarthropod feeding selectively on decaying plant organic matter, and preferring Mango leaf litter, when choice is offered (BANO & KRISHNAMOORTHY, 1981). The feeding activity depends on the nitrogen content of the food source, which was evident when different types of litter, cow dung and soils were offered. In the present experiment, smaller intakes were recorded with litter, and larger intakes were associated with soils in which organic nitrogen and carbon contents were low. If the surface layer was covered with organic matter, the activity of the millipedes was restricted to the surface. When soils alone were offered the millipedes exhibited burrowing activity, which is indicative of foraging behaviour for organic matter. The consumption of soil was important in the absence of leaf litter. These features allow the millipedes to get their nutritive requirements. There was no significant difference in the litter intake between the sexes. The mango litter consumption was more or less equivalent in both the sexes, but the soil consumption varied. The assimilation varied with soil and litter. The energy requirements of the millipedes were obtained mostly from proteins (62%), followed by fats (26%) and carbohydrates (1%).

The role of arthropods and particularly diplopods in soil-litter system has been described in various ways (cf. CRAWFORD, 1992). They are considered as accelerators, regulators and decomposers. While working on the millipede *J. splendidus* the author has elaborated similar interpretation for the role of this millipede (BANO & KRISHNAMOORTHY, 1976, 1977; BANO, 1992). The feeding activity involved destruction of litter as these millipedes feed on the soft tissues, leaving the veins and the fibrous portions to decay further. They contribute to the transformation of the organic constituents, improving the humic part of the soils. Their direct effect is the acceleration of the formation of humus, and the indirect effect is the incrementing of the microflora through their faecal pellets. With the present data it could be calculated that a millipede consumes 4 to 5 g of leaf litter (dry mass) in a period of six months, which could be taken as the active period of the millipede's life cycle. The distribution of the species varies in relation to the nature of the soils and organic matter. A maximum of 200 individuals/m2 was reported earlier (BANO & KRISHNAMOORTHY, 1985). This distribution would destruct about 1 kg of dry leaf litter per year, thus suggesting their role as decomposers in their habitats. Similar results were obtained by BLOWER (1974) with *Ophyiulus pilosus* regarding the mass of leaf consumed per year.

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